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EDITORIALS

THE YEAR'S ENROLLMENT

This year saw the largest enrollment ever recorded in the history of the College of Agriculture. *Six hundred twenty-seven* strong is the number. Of these, *two hundred forty-nine*, only one less than the admission limit set for new students this year, are new. This enrollment records an increase of 29 per cent and 16 per cent over that of 1919 and of 1920 respectively. It constitutes 18 per cent of the total enrollment of the University of over 4,000 students and is surpassed only by the College of Liberal Arts which has an enrollment of 662.

The distribution of students among the courses is as follows: Six Year General, 430; Four Year General, 57; Six Year Animal Husbandry, 64; Four Year Animal Husbandry, 9; B. S. Sugar Technology, 12; B. Agr. Sugar Technology, 3. Thirty-six students are post graduates, seven of whom are in the sugar technology course. There are 16 special students.

The students come from 45 provinces and sub-provinces of the archipelago, with Pangasinan, Batangas, Laguna, and Iloilo leading in representation. There are students from Bukidnon, Cotabato, Davao, Lanao, Zamboanga and Palawan. Eight students are from foreign countries: Siam, China, Japan and Java being represented.

Nearly all the students are living in or near the College Campus. Living so close together in a community where social intercourse among themselves is easy, they cannot help but develop a spirit of unity which begets loyalty to the University. We are not exaggerating when we say that in the College of Agriculture we have probably the most high spirited and splendidly organized Student Body in the whole University.

The increase of the enrollment of the College of Agriculture is indeed remarkable, taking into consideration the prejudices which our people in general have towards higher training in agriculture. From 55 students twelve years ago, it has steadily grown to the present number. Nor is this the maximum attainable for there is now a growing realization among the people, even among the most conservative farmers, of the value of scientific training in the development of our agriculture. In the years past one seldom found sons of prominent landowners studying in the College, now we see them here in considerable numbers. The growing demand for technically trained men in the production of

sugar together with the opening of our course in sugar technology is turning the attention of many of the best young men in the sugar provinces to the College of Agriculture. Then there is the demand which at present the College cannot meet, for technical men in all lines of agricultural work. With the crowding of other professions, even the city-bred boy, as in America, may find technical professions in agriculture a wholesome life work to engage in.

These and other conditions are bound to influence the mind of students graduating from the public schools and it is not too much to expect double the present enrollment within the next few years. The College must prepare to meet this increase. This year the admission of new students has been limited to two-hundred-fifty due to lack of equipment and lodging facilities. While the limit was not reached—only one was needed to reach it—it would have been passed and many boys denied the opportunity to obtain a higher education in agriculture, were it not for the economic crisis which is sweeping over the country and which forces many parents to keep their boys home. At the present rate of increase, unless something unforeseen happens to prevent it, next year will see the student body greatly outgrowing the College in its equipment and lodging facilities. Even with the present enrollment the College finds its teaching facilities not in proportion to the number of students. Shall we deny admission to students because the physical growth of the only institution for higher education in agriculture in the Islands is limited by the funds at its disposal? This is a fair question to put up to the authorities responsible. To say the least it is unfair to the people who support this public institution to deny their children the opportunity to acquire an education which would enormously benefit this truly agricultural country.

José J. Mirasol,
Registrar, College of Agriculture.

INCIDENCE OF HOOKWORM INFESTATION IN STUDENTS AT LOS BAÑOS

In the course of a survey, that is now in progress, concerning the incidence of infestation with internal metazoon parasites among students in Los Baños, we have observed a very striking discrepancy as regards the degree and severity of infestation of students of the College of Agriculture as compared with students of the College of Veterinary Science. We have adopted the hookworm index as a basis of comparison, on the principle that infestation with hookworms is indicative of unhygienic habits and of insanitary living conditions. Incidentally it may be stated, that hookworm is by far the most dangerous metazoon parasite encountered in the course of this survey. While infestation with ascarids and other intestinal roundworms does not, as a general rule, give rise to any well defined train of morbid symptoms, infestation with hookworms is very apt to be accompanied by anemia, emaciation, lack of ambition, and general dullness and apathy, that are commonly characterized as laziness.

Thus far the stools of 118 students have been examined, 54 of which are from students of the College of Veterinary Science and 64 from students of the College of Agriculture. Of the former, eight were found to be infested with hookworm, giving a hookworm index for the College of Veterinary Science of approximately fifteen per cent. Of the 64 students from the College of Agriculture 38 were found to be infested with hookworms, giving a hookworm index of

approximately sixty per cent. This glaring discrepancy is neither accidental nor inexplicable but was predicted by the writers early in the course of this investigation. Many students of the College of Agriculture may be seen barefooted on the Campus, as well as around their dormitories. While it is not likely that the cases of hookworm infestation encountered in this survey have been contracted in Los Baños, it is very probable that the students in question have been in the habit of going about barefooted in their homes. Negligence with respect to footwear is doubtlessly correlated with carelessness in other respects, such as drinking of polluted water, eating of food that has been contaminated and general lack of proper precautions as far as concerns hygiene and sanitation.

Recent newspaper reports indicate that the International Health Board is contemplating a health campaign in the Philippines. Judging from the results that we have thus far obtained, the hookworm problem will demand serious consideration in the event the contemplated crusade against diseases in the Philippine Islands is undertaken. In view of the recognized importance of hookworm disease and of the harm that it is capable of inflicting upon its victims, a campaign of eradication and of education as regards methods of prevention should be undertaken by the Insular Government, irrespective of any action that the International Health Board may take. The cases of hookworm found among students in Los Baños will receive medical attention and it is hoped that students harboring these unwelcome guests will co-operate with the Medical Department of the College of Agriculture and with the Department of Parasitology as regards the submitting of samples for examination and reporting for treatment when instructed to do so.

The hookworm survey that is now being carried on in Los Baños may well serve as a model for anti-hookworm campaigns in various communities of the Archipelago. A well-organized campaign against hookworm will not only relieve a large proportion of the population of serious parasites that are a drain upon their physical resources, but will also tend to improve sanitary conditions in the Islands and will do much to abolish infectious diseases that are water borne and filth borne.

Thus far our study has been strictly zoological, the main object being to determine the incidence of infestation of the population of the Philippines with various intestinal parasites, especially hookworms, based on the student population at Los Baños. Following the preliminary examination for parasites, it is planned to make inquiries into medical history of the students examined, and to carry out certain laboratory tests with a view of correlating parasitic infestation with possible morbidity and chemical changes in the body fluids.

Benjamin Schwartz,
Marcos A. Tubangui,
Of the Department of Veterinary Pathology and Bacteriology.

Sixto A. Francisco,
Physician to the College of Agriculture.

VARIATION AND CORRELATION OF CHARACTERS AMONG RICE VARIETIES WITH SPECIAL REFERENCE TO BREEDING[1]

By Toribio Vibar
Of the Department of Agronomy

INTRODUCTION

THE PROBLEM

Rice (*Oryza sativa* Linn.) is very rich in varieties. In the College of Agriculture, about 300 varieties, a little more than half of which are lowland rice, are under continuous culture. Eight hundred fifty-three varieties (1) were tested out and identified by the Philippine Bureau of Agriculture in 1915. Hill and Moe (2) state that 1,263 varieties are found in the Islands. In the Calcutta museum, there are not less than 1,104 different varieties collected from British India (3). Watt (4) states that the collections of rice brought together in the Indian museum "come to something like 5,000 forms". He, however, expressed the opinion that they are probably not all distinct. A variety of rice may be named differently in different places thus seemingly making the accepted number of varieties considerably larger than what it really is. In 1908, 828 samples of rice were collected by the Philippine Bureau of Agriculture from thirty provinces under 2,430 variety names (1). But even if duplication in name is granted, it is generally admitted that the varieties of rice found in the Philippines, number not less than 1,000.

The multiplicity of rice varieties points, according to Watt (4), to the antiquity of the cultivation of this cereal. Gutierrez (5) found the presence of natural hybrids in his rice cultures. It is now conceded that natural hybridization takes place, at least among certain varieties of rice; and that this phenomenon may lead to the creation of new varieties.

Because of this large number of varieties, it would be of great value to find to what extent the apparent characters among them vary, and to determine the degree of association of each of these characters with the power to reproduce and with the power of maturity.

PAST WORK IN VARIATION AND CORRELATION

Clark (6) in "a study of 3,500 plants for a period of three years" to determine the variation in timothy and the relation of the measurable characters to each other, concluded that there was a wide range of variation "in all the characters" studied, and that there were practically "no correlations of these characters except in case of weight and height".

Myers (7) planted wheat in soils of varying fertility to determine the effect of fertility upon variation and correlation. His conclusion from the data obtained was that there was slight correlation between number of culms and weight of kernel, and between tall plants and heavier kernels. He also concluded that "all correlations are greatest upon poorer soils and that increased fertility tends to decrease variability."

[1] Thesis presented for the degree of Master of Science from the College of Agriculture, No. 124; Experiment Station contribution, No. 55.

Leighty (8) investigated the correlation of characters in oats with special reference to breeding. He secured his data from 500 plants, and made the following conclusions: "Tall plants are better yielders than short ones." "As the number of heads borne by the plants increases, the amount of grain obtained from each culm also increases." He pointed out that there is probably a difference as regards correlation of characters between different varieties or between pure lines and varieties.

Love and Leighty (9) in their studies on the effect of seasonal changes on biometrical constants concluded that "correlations are more or less responsive to environmental conditions". They divided correlations into fluctuating and stable, depending on their behavior under differing environment. They also concluded that conditions resulting in the decrease of yield, result also in the decrease of height, number of kernels, and number of culms.

Studying varieties of oats, Leighty (10) found considerable difference in the yield of culm per plant, in the height of culms, in the number of kernels per spikelet, and in the amount of variability of different characters of the varieties. The coefficients of correlations, however, were fairly close together for the different varieties. Comparing the biometrical constants for oat plants grown in hills and in drills, he found greater means but smaller coefficient of correlations from plants grown in hills than from plants grown in drills. Crowding oat plants was found to decrease variability in yield, number of kernels, number of spikelets, and breaking strength of straw. To a certain degree, correlations of these characters were greater in the crowded conditions.

At the Genetic Station of Varrieres, Seine-et-Oise, near Paris, during the winter of 1917 when the temperature sometimes fell to —16 degrees Centigrade, M. J. de Vilmorin (11) classified, according to their resistance to frost, the winter wheat grown in the Experiment Station plots into five classes, (a) varieties which resisted well, (b) varieties which suffered slightly, (c) varieties, one half of the crop of which was destroyed, (d) varieties which suffered greatly, and (e) varieties completely frost-bitten. He made the classification expecting to discover some characters correlated with resistance to frost. Vieules (11) working on selection at Nages, Tarn, at an altitude of 2,620 to 2,950 feet found a marked correlation between the color of glumes and of the grain of winter wheat and their resistance to frost. He stated that red glumes and red grains are indices of resistance to frost; while white glumes and white grains show sensitiveness to frost. By comparing Vieules' list with that of Vilmorin, it was found that pigmentation of grain and glumes was positively correlated with resistance to frost.

Lutz (12) collected insects under the genus *Gryllus* from different states in the United States. He studied the tegmina, wings, legs, and ovipositors of these insects, and found out that these characters are greatly affected by the local conditions; but that in spite of the effect, there were very high positive correlations among them.

Studies made by Rietz and Smith (13) on the measurement of correlations with special reference to some characters of Indian corn show high positive correlations for length-weight, and circumference-weight of ears; fairly high correlations for circumference-rows of kernels, and length-circumference; low correlation between weight and rows of kernels; and an insignificant correlation for length and rows of kernels.

Ewing (14) reported that of the fourteen characters he used as relatives, the diameter of the stalk, and the height of the plant showed highest correlations with yield in corn.

Collins (15) crossed Esperanza and Waxy Chinese, two varieties of corn of contrasting characters in order to secure a hybrid which would make a good material for the study of the tendency of characters associated in one of the parents of the hybrids to remain together in the offspring. He selected eleven characters of the hybrid and made out of them fifty-five combinations, twenty combinations of which were found to exhibit significant correlations. He concluded that "in no instance was there a correlation between two characters closer than 0.5, a fact which in itself offers an explanation of the difficulty of recognizing types in maize". He maintains that the lack of coherence of characters in maize, though a limitation, is advantageous to the breeder in that it makes possible the combination of desirable characters from different parents.

According to Love (16), Williams of the Ohio Experiment Station compared the yield of long and short ears of corn, heavy and light ears, tapering and cylindrical ears, and bare and well-tipped ears, and found that long ears produced 3.79 bushels more per acre than short ears, tapering ears 0.87 bushels more than cylindrical ears, ears well filled 1.07 bushels more than bare ones, smooth, slightly more than rough, and heavy seed ears 1.95 bushels more than light seed ears. Williams worked with characters of greater extremes. Love in his work used characters which did not differ so markedly. Love reported that in three out of four cases, there was a positive correlation for length of seed ear and yield; and that in every case, there was a positive correlation for weight of seed ear and yield. On the other hand, he found that the number of rows, the average weight of kernel, and the ratio of tip to butt had no relation to yield.

Mariano (17) studied the effect on yield of short ears, seeds from different parts of the ear, and ears of different number of rows of kernels of corn. He concluded that there was no significant relation between these characters and yield. Pearl (18) working with sweet corn concluded from his preliminary work that "the external characters of the ear are a very unreliable indication of its probable worth for seed purposes."

Olson, Bull, and Hayes (18) made a rather extensive investigation on the relation of external characters of corn to yield. In their ear-to-row cultures, they studied the relation to yield of corn, of length of ears, weight of ears, circumference of ears, shelling percentage, butts of ears, tips of ears, kernel uniformity, variety character, and total score of ears. They found rather significant correlations for shelling percentage and yield, and for total score and yield. They concluded that while some of the correlations are statistically significant, they are certainly not significant for practical purposes".

Conner (19) compared the production of 279 Indo-Chinese varieties of rice with the same number of Philippine varieties, grouping the varieties according to yield and days to maturity. He presented graphs showing the months required to maturity, the yield, and the number of varieties maturing in different months to prove that there is no relation between time to maturity and yield.

Jacobson (1), formerly of the Philippine Bureau of Agriculture, investigated the correlation of characters in rice. He worked with lowland varieties, basing his results from the "returns obtained from 1,440 plants". He admitted that

certain of his measurements were rather coarse for the construction of some of his tables. The following is an epitome of the characters he worked out and their correlative interpretations:

Characters positively correlated: Days to maturity and yield of grain, tillering and yield of grain, length of culm and yield of grain, number of grains per panicle and days to maturity, grain length and days to maturity, grain dimension ratio and days to maturity, average number of nodes per variety and average internodal length, average length of panicle and average length of culm, average length of rachis per variety and average length of culm, average diameter of culm per variety and average length of culm, average length of rachis per variety and average number of branches per panicle per variety, average number of nodes per variety and average length of culm.

Characters negatively correlated: grain width and days to maturity, and number of grains per panicle and tillering.

Characters showing no correlation: number of grains per panicle and yield of grain, length of grains and number of culms per plant, grain dimension ratio and tillering, grain dimension ratio and yield of grain, number of culms per variety and length of culms, number of culms per plant and days to maturity.

Jacobson concluded that:

The time to maturity does not have appreciable effect on yield of rice if it is not less than 120 days nor more than 180 days, and under normal conditions of growth.

Extra early maturity is to be had at the expense of yield.

A variety that tillers will produce more grain per hectare than one that does not.

The height of the plant has noteworthy effect on the yield.

The number of grains per variety is dependent on the tillering habit, the grain dimension ratio and the density.

Grain length has a positive correlation with days to maturity.

The length of the rachis corresponds to the length of the culm.

Long culms have more nodes than short ones.

More branches are found on panicles of long rachis than on one with short ones.

Very recently Labrador (20) of the College of Agriculture gave the following figures for correlation coefficients between breaking strength of culm of rice and yield:

Variety Binicol, initial selection	$+0.328 = 0.031$
Variety Binicol, F_1	$+0.411 = 0.334$
Variety Inintiw,[1] initial selection	$+0.374 = 0.041$
Variety Inintiw, F_1	$+0.276 = 0.304$

This shows, therefore, that the breaking strength of the straw of rice, as far as these two varieties are concerned, is positively correlated with yield. This may mean either that the stronger the straw of the plant, the more it will yield, or that good yielders have high breaking strength of straw.

Collado (21), in order to determine the effect of selecting larger and heavier seeds of rice on the yield, planted grains of differing size and weight of two standard varieties of rice, the Binicol and the Inintiw. He conducted pot and plot cultures. While he obtained some results in favor of large and heavy seeds, he admitted that the yield differences were not significant. It is interesting to note in this connection that, according to Doctor Mendiola of the College of Agriculture, D. Meade reviewed a paper in the Cornell Plant Breeding Seminar on No-

vember 3, 1917, showing significant positive correlation between weight of parent seeds and yield per plant, number of culms per plant, and number of kernels per plant. However, Doctor Mendiola asserts that results of experiments with cereals covering a period of twenty-five years are, in the main, against the belief that size and weight of grains are correlated with yield.

Peralta (22) in his study on the relation of climatic conditions to the vegetative growth and seed production of rice reported positive correlations within a variety between weight of grain and weight of straw, length of panicle and yield of grain, days to maturity and leaf products, and yield of grain and height of plants.

In the Philippines, we are chiefly interested in the correlation work in corn and in rice. Regarding corn, the status of the correlation of characters, from the investigations reviewed in connection with this work, is not definitely settled. The findings of the various investigators do not agree. The probable reason is that they worked under different conditions and with varieties of varying degrees of purity. The weight of opinion up to the present time seems to favor the conclusion that the external characters of corn have no relation to yield.

The correlation work on rice, so far reported, shows, in general, that some characters, especially the significant ones, are associated with each other, and that the characters found to have no correlation with each other are mostly those of minor importance. That the height of the plant is positively correlated with yield is almost definitely settled. It is believed that the study of the relations of the other characters of rice has not been carried on long enough and is not enough to warrant definite conclusions. Considering the number of characters of the rice plant, the climatic and soil conditions in which the plant is raised, the enormous number of varieties and the impurity of these varieties, there is no doubt that the field of study of correlation of characters in rice is very fertile. In this work, only the correlation of characters among rice varieties was taken up using the two important characters, period of maturity and yield of grains, as subjects.

OBJECT OF THE PRESENT WORK

Rice breeding in the Philippines is yet in its infancy. At present, stress is laid on the selection of standard varieties of rice, or the elimination of low yielding ones. The investigation reported in this paper was conducted mainly as a basis in the selection of desirable varieties and to find an answer to the following questions:

Are the late-maturing varieties heavy grain yielders?

Do tall varieties produce more grains than short ones?

Is there any relation between the length of the leaves, the length of the panicles, and the length of the grains on the one side and the power of the plant to reproduce on the other?

What relation have the width of the leaves, and the width of the grains to the productive power of rice varieties?

Have the number of nodes and the number of spikes in the panicles anything to do with the yield of grain?

Do tall varieties mature late?

Are varieties with long leaves, long panicles, and long grains late maturing?

Have the number of nodes, and the number of spikes in the panicles any relation to the days of maturity of rice varieties?

Have the width of the leaves and the width of the grains any relation to the days of maturity?

Is it true that varieties producing much straw require more time to mature?

TIME AND PLACE OF THE PRESENT WORK

This work was carried on during the rice season of 1919-1920. The different varieties of rice were planted in the paddies lying to the right of the road entering the College of Agriculture grounds, and in paddies on Experiment Station farm. All the varieties were planted on time. The season was favorable. The soil is uniform, fairly rich, and typical of the College Farm.

MATERIALS AND METHODS

VARIETIES OF RICE USED

For this experiment, 109 varieties of rice were planted, but only 85 of these were used for the study of variation and correlation. The twenty-four varieties that were discarded were either duplicates, mixed, or otherwise undesirable for use. Of the 85 varieties selected for study, 16 are upland; 69, lowland; 30, awned; and 55, awnless; 7, glutinous; and 78, nonglutinous; 64, white rice; 4, red; 2, black; and 15 have slight mixtures, some of which are undoubtedly hybrids.

CULTURES

Soil that is fairly rich and uniform was selected. To prepare it thoroughly, it was turned under with spading fork, made fine and leveled with rake. Lots of 10 meters by 3 meters were laid out separated by a one-meter path. The lowland varieties were planted 25 centimeters apart with three plants to the hill, and the upland varieties in shallow furrows. The plots were kept free from weeds, practically all the time. The season was good. During the whole period of growth, the plants were sufficiently supplied with moisture.

GETTING THE DATA

At maturity, 100 plants from each variety were pulled up at random. The data from the 100 plants of each variety was tabulated. (Table I.)[1]

The averages of 100 determinations based on 100 plants per character per variety were tabulated. (Table II.) A total number of 8,500 plants were used in this study.

The average weight of the grains in Table II was the total weight of the clean grains from 100 plants divided by 100. The days to maturity were counted from the time the seeds were planted. The length of culm was measured from the point above the roots to the tip of the panicle. The length of the panicle was measured from the last node of the culm to the tip of the panicle. In finding the average number of the nodes per panicle, the number of nodes in each panicle was added and averaged; so also with the number of spikes per panicle. Only the broadest leaf and the longest leaf in each culm were measured. The data on the width of the grains and the length of the grains were secured from 20 grains of each variety. The weight of the straw was the total weight of the plant less roots and grains.

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1 All tables prepared in the investigations reported in this thesis are on file in the College of Agriculture. These tables will be sent to any one who may desire them,

The tables are too extensive for the space limitations of the **Philippine Agriculturist.**

OBSERVATIONS AND RESULTS

VARIATION OF CHARACTERS AMONG RICE VARIETIES

There is a very wide range of variation in the characters of different varieties. In the following is shown frequency distributions of these characters:

Days of Maturity

V	f
days	
100—120	3
121—140	21
141—160	21
161—180	22
181—200	16
201—220	2

Mean—158.24 days

Length of Culms

V	f
cm.	
80.00— 96.66	21
96.67—113.33	20
113.34—130.00	25
130.01—146.67	13
146.68—163.34	3
163.35—180.01	3

Mean—98.72 cm.

Length of Panicles

V	f
cm.	
14.00—17.33	6
17.34—20.67	25
20.68—24.01	24
24.02—27.35	22
27.36—30.67	5
30.68—34.03	3

Mean—22.50 cm.

Number of Spikes per Panicle

V	f
4.00— 6.50	5
6.60— 9.10	20
9.20—11.70	35
11.80—14.30	13
14.40—16.90	10
17.00—19.50	2

Mean—10.73 spikes

Number of Nodes per Panicle

V	f
5.00— 6.86	26
6.87— 8.73	29
8.74—10.60	18
10.61—12.47	10
12.48—14.34	1
14.35—16.21	1

Mean—8.11 nodes

Width of Broadest Leaves

V	f
mm.	
6.83— 8.69	15
8.70—10.56	23
10.57—12.43	20
12.44—14.50	13
14.51—16.37	8
16.38—18.74	6

Mean—11.17 mm.

Length of Longest Leaves

V	f
cm.	
10.00— 30.00	2
31.00— 50.00	37
51.00— 70.00	41
71.00— 90.00	4
90.00—110.00	0
111.00—130.00	1

Mean—52.48 cm.

Width of 20 Grains

V	f
mm.	
2.00	3
3.00	58
4.00	24

Mean—3.25 mm.

Weight of Grains		Length of 20 Grains	
V	f	V	f
gm.		*mm.*	
1.00— 3.00	37	5.00— 5.92	1
4.00— 6.00	33	5.93— 6.85	4
7.00— 9.00	12	6.86— 7.78	12
10.00—12.00	1	7.79— 8.70	44
13.00—15.00	1	8.71— 9.64	17
16.00—18.00	1	9.65—10.57	7
Mean—4.44 gm.		Mean—8.33 mm.	

Weight of Straw per Plant

V	f
gm.	
2.50— 8.75	45
8.76—15.01	24
15.02—21.27	9
21.28—27.53	2
27.54—33.79	3
33.80—40.05	2
Mean—10.78 gm.	

THE CHARACTERS USED AS SUBJECTS IN THE STUDY OF CORRELATION

Of all the characters of the rice plant, the power to yield grains and the time it takes the plant to mature are at present considered the most important ones. The weight of the straw will become more important than it is now when its use as feed becomes more general.

In this correlation study, therefore, the yield and the days to maturity were used as the subjects. The computation of the coefficient of correlation with yield as the subject was made. The formula of Pearson was used (23).

The computation of the coefficient of correlation between days to maturity and other characters was made.

METHOD USED IN COMPUTATION

Carl Pearson's method of determining the coefficient of correlation is a long one requiring much work with figures. It is believed, however, that there are fewer discrepancies with this method than with the shorter method. The Tables of Squares, Square Roots, etc., by Davenport were used freely. All additions were made with a Barrett adding machine, and the figures were checked carefully several times.

The following are the coefficient of correlations obtained:

Yield and Days to Maturity	0.5613 ± 0.0498
Yield and Length of Culm	0.4616 ± 0.0579
Yield and Length of Panicle	0.4704 ± 0.0566
Yield and Number of Nodes in the Panicle	0.4977 ± 0.0547
Yield and Number of Spikes per Panicle	0.1677 ± 0.0052
Yield and Width of Broadest Leaves	0.1967 ± 0.0448
Yield and Length of Longest Leaves	0.1547 ± 0.0554
Yield and Width of Grains	0.0591 ± 0.0474

Yield and Length of Grains	0.3233±0.0651
Yield and Weight of Straw	0.1250±0.0614
Days to Maturity and Length of Culm	0.2050±0.0421
Days to Maturity and Length of Panicle	0.1270±0.0611
Days to Maturity and Number of Nodes in Panicle	0.1094±0.0640
Days to Maturity and Number of Spikes per Panicle	0.0431±0.0592
Days to Maturity and Width of Broadest Leaves	0.2089±0.0412
Days to Maturity and Length of Longest Leaves	0.9042±0.0132
Days to Maturity and Width of Grains	0.0602±0.0467
Days to Maturity and Length of Grains	0.2971±0.0856
Days to Maturity and Weight of Straw	0.5785±0.0484

DISCUSSION OF RESULTS

There were found very wide ranges of variation in the characters studied. These were chiefly due to varietal characteristics. The influence of the external factors, soil and climate, however, can not be entirely ignored.

King (23) holds that if a coefficient of correlation is six times its probable error, the existence of correlation is a practical certainty. He maintains also that if it is less than 0.30, the correlation can not be considered marked, and that if it is above 0.50, the characters involved are decidedly correlated. East (14) agrees with King in that the coefficient of correlation to be of value in breeding should be over 0.50.

In this study, therefore, using King's standards, there were found decided correlations between yields and days to maturity, days to maturity and length of longest leaves, and days to maturity and weight of straw. There were marked correlations between yield and length of culm, yield and length of panicle, yield and number of nodes in the panicle, and yield and length of grains. There were slight correlations between yield and number of spikes per panicle, yield and width of leaves, yield and length of leaves, yield and weight of straw, days to maturity and length of culms, days to maturity and length of panicles, days to maturity and number of nodes per panicle, days to maturity and width of leaves, and days to maturity and length of grains. On the other hand, there was no correlation between yield and width of grains, days to maturity and number of spikes per panicle, and days to maturity and width of grains.

Jacobson (24) found that the coefficient of correlations between days to maturity and yield of grains was 0.403±0.058, which according to King's interpretation of the coefficient of correlation is a practical certainty. Jacobson made the statement that "extra early maturity is to be had at the expense of yield," although he admitted that late maturing varieties of rice are subject to unfavorable conditions of climate, and to the effects of diseases which may cause reduction in the yield. Varieties that are early maturing and extra late varieties should not be selected for yield unless special circumstances so demand. In places where the rainy season is long and in irrigated rice land, other conditions being equal, selection for yield should be made from varieties requiring about 160 days to mature.

Late maturity was found positively correlated with weight of straw and length of longest leaves. The length of the leaves and the weight of the straw are decidedly correlated with the period to maturity, the coefficient of correlations

of days to maturity and the length of the leaves being 0.9042 ± 0.0132 and days to maturity and the weight of the straw 0.5785 ± 0.0484. There exists a slightly positive correlation between yield and length of leaves and between yield and weight of straw. The physiological reason for this phenomenon needs no explanation. The mean length of the leaves of the varieties used in this study was 52.48 centimeters. It is, therefore, likely that varieties having longer leaves than 52.48 centimeters are late maturing and heavy yielders.

An outstanding feature which was brought out from this correlation study, and which should be of great interest to the rice breeders is the fact that the length of the culm, the length of the longest leaf, the length of the panicle and the length of the grain are somewhat correlated with the days to maturity and that these same characters are also decidedly correlated with yield. It is rather unfortunate that high-yielding varieties are tall varieties generally. In regions where typhoons prevail during certain parts of the year, tall varieties are supposed to be undesirable. The prejudice against growing tall varieties in these regions and the weight given to this prejudice, however, is believed to be exaggerated. In fact, if typhoons prevail during the flowering and maturing period of the crop, no rice variety short or tall can escape injury.

The number of nodes in the panicle has a decided correlation with yield but a negligible one with the period to maturity. Jacobson (24) used the number of nodes of the culm in his correlation study. He found this character to be associated with the period to maturity. The number of nodes in the panicle is an easier character for the breeder to work with than the number of nodes in the culm. The reason is evident; the former can be determined more easily than the latter. It will require much less effort to count the number of nodes in the panicle than to count the number of nodes in the culm.

The number of spikes in the panicle has practically no relation with yield, much less with days to maturity. This character is consequently of no value to the breeder.

The same is true with the width of the grain. This character has also no relation with yield and days to maturity. The correlation coefficient between width of leaves and yield of grain and between width of grain and period of maturity are 0.1967 ± 0.0448 and 0.0602 ± 0.0467 respectively. They are high enough statistically; but from the point of view of the breeder they are probably of no great value.

CONCLUSIONS

From the results obtained, the following conclusions may be drawn:

(1) The longer the time it takes varieties of rice to mature, the more they will yield in grain.

(2) Tall varieties produce more weight of grains than short ones.

(3) Long leaves, long panicles, and long grains are varietal qualities indicating high yielding power in rice. These characters are also associated with days to maturity.

(4) The width of the broadest leaves, and the width of the grain have no relation to the yielding power of rice varieties nor to the period required by these varieties to mature. The number of spikes in the panicles has also no relation to yield and to days to maturity.

(5) The number of nodes in the panicle is strongly associated with yield but not with the period of maturity.

(6) Varieties producing much straw are not necessarily heavy yielders; but they are generally late maturing.

Of the nineteen pairs of characters taken up in this investigation, four pairs were included in Jacobson's work (24), –days to maturity and yield of grains, length of culms and yield, length of grain and days to maturity, and width of grain and days to maturity. The results obtained in the present work substantiate those of Jacobson on the days to maturity and yield, length of culm and yield, and length of grains and yield. Width of grains and days to maturity were found by Jacobson to be negatively correlated. In this work, they were found to have no correlation at all.

On the subject of correlation of characters among rice varieties, and within rice varieties, there is still much to be done in the way of checking past work and of undertaking new.

ACKNOWLEDGMENT

Dr. Sam F. Trelease, formerly of the Department of Plant Physiology of this College, suggested the subject of this investigation, and gave very valuable suggestions in the preliminary part of the work. To him I am indebted. I am especially indebted to Dr. Nemesio B. Mendiola of the Division of Plant Breeding, Department of Agronomy, for placing at my disposal his literature relating to correlation work and for his suggestions and advice in putting this paper in its final form. I am also indebted to several students without whose help the collection and the computation of the data compiled in the tables and the results presented in this paper would have been impossible.

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Men talk as if victory were something fortunate. Work is victory. Wherever work is done, victory is obtained. There is no chance, and no blanks.—'Emerson', *Worship.*

INSTRUCTION AND INVESTIGATION IN PLANT BREEDING IN THE PHILIPPINES

By Nemesio B. Mendiola,
Of the Department of Agronomy

WITH TWO PLATES

The desire for and the appreciation of an improved variety of plant or fruit seems to be instinctive with the Filipinos as with other people. When on a family table sweet fleshy papayas or sugary tamarind pods are opened, there comes, immediately, the suggestion that the seed be planted on the farm or in the home garden. The native term *pang regalo*, which may be translated "for a gift," indicates that Filipinos appreciate the best and also shows their peculiar hospitality. If a farmer harvests extra good fruits, the first thought that strikes him is that they will be good for gifts, *regalos;* they will seldom be sold, but given to a visitor or a benefactor or a friend.

NEED OF PLANT BREEDING INSTRUCTION AND RESEARCH

In order to become a practical plant breeder, however, the Filipino farmer must first free himself from superstitions and old beliefs. So long as he believes that a tall banana plant will grow out of a sucker if he looks up while transplanting it; or that big fruits will be produced if he eats heavily before dropping the young plant into its hole, so long will it be impossible for him to obtain with certainty the strain which he would most prize. But superstition melts under the first rays of the light of education, and the rising generation of Filipino farmers who are now in the public schools of the Islands will look at their farm problems from a more scientific attitude than their fathers do.

There are undesirable beliefs, however, not wholly confined to Filipinos, which technical explanation, alone, can cause to disappear. It is rather interesting that Darwin's idea of cumulative effect of selection should find believers even among people who do not read literature on the subject. Like other unschooled farmers, the Filipino takes it for granted that he can improve the producing ability of his crop by selecting his seeds merely for size. After selecting, for example, for seed corn the biggest ears in a lot containing a mixture of different yield strains, he assumes that the field planted with this seed will give a better yield than if he selected small ears. And by a repetition of this mode of selection, he expects to get better and better returns.

There is need for the guiding hand of education and the torchlight of science to develop the plant breeding instincts of the Filipinos into a real and useful knowledge and introduce the art into more general practice.

Instruction in the applied science of plant improvement, however, is possible for Philippine conditions only when careful research and observation have brought out and organized the facts necessary to constitute the science. In the Philippines, much, probably too much, is expected of plant breeding. However, very little is known along this line and investigators in plant genetics are very few. While knowledge of Philippine conditions may be supplemented with

discoveries in Java, India, and other tropical countries, the fact still remains that there is an urgent need and an opportunity for plant breeding research in the Philippines.

BEGINNINGS OF PLANT BREEDING INSTRUCTION AND RESEARCH IN THE PHILIPPINES

The inclusion of a course in plant genetics in the curriculum of the College of Agriculture, as well as the inauguration of active research in the Philippines on this very new but important branch of agricultural science are due to the initiative of Prof. Charles F. Baker, now Dean of the College. When he came to this institution in 1913, as Professor in Agronomy and Chief of the Department, one of the courses he organized was Agronomy V which is Plant Breeding. At almost the same time, two of his senior students were assigned to take up research work on hybridization of tobacco and hybridization of corn. It is also probable that at Professor Baker's suggestion, the Bureau of Agriculture began its plant breeding studies on rice, the staple crop of the Philippines. Since then, interest in plant breeding has been greatly increased and the Government of the Philippine Islands has been convinced of its necessity and importance.

COURSES IN PLANT BREEDING IN THE COLLEGE OF AGRICULTURE

The College of Agriculture, offers two undergraduate courses and one advanced course in Plant Breeding or Plant Genetics. Each covers a one-semester period. The first course consists of lecture and laboratory sessions combined, and is modeled after the first two undergraduate courses offered in Plant Breeding in Cornell University. The course aims to give the students a fundamental understanding of the facts and laws underlying the phenomena of variation and heredity in their broadest sense and the relation of these to environment. The second course is Methods of Plant Breeding with special adaptation to the Philippines and to the tropics. The third course is Elementary Biometry. Considering that all these courses are elective, it may be said, judging from the number of students who have taken them, that Plant Breeding is a fairly popular study.

PLANT BREEDING INVESTIGATIONS IN THE COLLEGE OF AGRICULTURE

Investigations in plant breeding in the Philippines are being undertaken in the College of Agriculture and in the Bureau of Agriculture.

The Philippine Government is not rich and can not afford to finance investigations in the field of pure science. Hence practically all the work which has been accomplished so far in plant breeding has been of an applied character if not of immediate practical application.

As may be expected, rice, corn, and sugar cane, which are among the most important crops of the Philippines, have received the greater attention and study. Although one of the principal crops, the coconut, because it is slow growing, has not been taken as fit material for genetic research.

CONCLUSION

While in the last ten years there has been plant breeding investigation in the Philippines, nevertheless, it is realized that genetic research is barely begun, the art of correct plant breeding hardly practiced, and a vastly greater number of investigators must take their places in this virgin field if plant improvement is ever to play a real part, as it should, in the agricultural development of the country.

While it is true that there will be henceforth a gradually increasing number of Filipinos trained in plant breeding, yet this number will remain limited for a long time. For this reason foreign investigators, tropically inclined, will find in the Philippines a splendid opportunity for fruitful research and service.

Agronomy seed house where plant breeding seeds are cleaned and stored.

Fig. 1. The right wing houses the Division of Plant Breeding (Plant Genetics).

Fig. 2. Plant Breeding class selecting the best of new sweet potato varieties produced in the College.

PLATE I.

Fig. 1. Plant Breeding Class transplanting the second batch of sugar cane seedlings of the College.

Fig. 2. Plant Breeding Class mass-selecting rice in Barrio Maahas, Los Baños.

PLATE II.

PHILIPPINE CONTRIBUTIONS ON AGRICULTURAL, BIOLOGICAL AND INDUSTRIAL CHEMISTRY

By Francisco A. Quisumbing

Of the Depariment of Agricultural Chemistry

The bibliography here presented consists of papers on agricultural, biological, and industrial chemistry published in the Philippines during the last fourteen years (from 1906 to 1920). Most of this work has been done by the Bureau of Science and by the University of the Philippines. This list of references was compiled and is given here to aid research chemists to obtain the literature bearing upon the work accomplished during the short period of scientific chemical investigation in the Islands; and also to indicate the wideness of the field for research.

The Philippine soils have been investigated quite extensively by Cox and others of the Bureau of Science, still, a great amount of work remains to be done. There seems to be a pressing need of a more comprehensive geo-chemical survey coupled with a physico-bacteriological survey of the Philippine soils. Some of the problems which also might be of interest in this survey are the nitrification of soils in rice paddies; bacteriological study of soils on which different leguminous crops are being grown; soil acidity; organic matter, its preservation and how it could be absorbed to greatest advantage by the soil, etc.

The question of fertilizers is no less interesting than soils to chemists. Leguminous crops are the cheapest source of nitrogenous fertilizers and these are grown everywhere in the Islands and can be grown at all times of the year. Besides this source, ammonium sulphate is produced at the Manila gas works and is sold cheap. Guano, fish, slaughter house refuse, waste from the sugar centrals, oil cakes from oil refining mills, and stable manure, can be secured also and used for nitrogenous fertilizer.

The Philippine supply for potash and phosphate fertilizers is limited, bat guano being the only local source of phosphate fertilizer that is commercially developed.

The bio-chemistry of foods and food products is an extensive and attractive field for investigation. It appears that only a very limited amount of investigation has been done on the composition and nutritive value of Philippine vegetables, fishes, and edible mollusks. Their relation to the Filipino diet and to local diseases has been barely touched; no properly established balanced rations for people leading different kinds of lives have been made. The writer suggests that more experiments on the line of plane nutrition should be made. Also, a bio-chemical study of the Philippine foods and food substitutes, such as, cassava flour; salted products and their preservation; a study of native fruits and preserves and their prophylactic properties, etc. These and a group of related problems are practically untouched by students in bio-chemistry.

Industrial chemistry offers a still more extensive field for investigation. The Bureau of Science has contributed an enormous amount of work in the opening up of the gold, copper, iron, manganese, and coal mines and petroleum

wells. The only iron castings, and the amount is small, produced for local use are obtained from native furnaces. Manganese and an amphibole variety of asbestos exist and are mined in relatively large quantities in Ilocos Norte. A small plant has been erected near Manila for the manufacture of articles made of asbestos, such as, roofing, sideboards, steam pipe coverings, paints, high grade cement, etc.

The disturbed conditions of the world for the past few years have increased the market for coal, crude oils and gasoline; for this reason more investigation work should be directed at once to the opening up of the coal mines, petroleum wells, oil shales, and asphalt deposits. Any step taken in the direction of developing these industries requires the employment of trained chemists and engineers and the most needed element—capital.

Enough work has been done on clays to indicate the possibilities of manufacturing china and porcelain, all of which commodities are now imported; local pottery industries are being carried on. There exist deposits of kaolin, fire clays, brick clays, pot clays, etc., sufficient for the manufacture of all our porcelain, pottery, tiles and bricks. Work has been done on the utilization of raw materials for the manufacture of glass.

To the sugar cane and coconut industries equal importance has been given in investigations. The sugar cane industry has been developed rapidly in very recent years. Several centrals are now operating in the islands of Luzon and Negros. Coconut oil refining companies can now be found in the coconut regions and in Manila.

Investigations concerning the lumbang oil industry show that business communities have begun to direct their attention to the commercial possibilities in the utilization of modern methods of extraction of lumbang oil and other drying oils, known to be available in large quantities in the Islands. There is a possibility of substituting these oils for imported linseed oil.

The soap industry has already made strides in development. At present we manufacture enough cheap toilet soaps and laundry soaps to partially supply the local demand.

These and problems of a similar nature are of great importance to the development of Philippine industry. However, investigations to which chemical research men should direct their attention, are those which will demonstrate the utilization of local products in the manufacture of articles which are being imported at present. These problems are of national interest, and research along this line should be encouraged by the Philippine Government. There should be more extended work on the Philippine medicinal plants; vegetable oil industry; soap manufacture, hydrogenation of oils; rancidity of oils; commercial investigation of the forest products that are available in commercial quantities. Work should also be extended for the advancement of the canning industry, for the preparation and preservation of vegetables, fish, etc. Also, further chemical and bacteriological study of the effect of tropical conditions on the storage of food-stuffs and commercial products in large quantities, such as copra, salted fish, etc., should be made. Other problems of interest are the paste industry for the manufacture of products similar to imported noodles, spaghetti, macaroni; the development of margarine products and other food substitutes; the furtherance of the paper pulp industry; promotion of the tanning and leather industry and a host of similar industries.

These and similar problems are most inviting. Industrial chemists will find the Philippines to be an almost unexhaustible field for research.

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COLLEGE AND ALUMNI NOTES

President Benton visited Los Baños on August 28 and received the Faculties at an informal reception at Copeland House in the evening. During his stay at Los Baños the President climbed Mount Makiling and inspected in part the National Botanic Garden. He spoke enthusiastically of the magnificent view from the crest of "our mountain".

Captain Wooley, of the English Forest Service, spent several days during the latter part of August on the Campus. He is on his way to join Doctor Foxworthy in the Federated Malay States.

In the *Outlook* for August 10 appears "The Hermit Kingdom," a forceful article by Prof. Emma S. Yule of the English Department of the College. The article describes the Japanese overthrow of Korean culture. The ruling class in the peninsula is unfavorably compared with the Japanese in his native land. Considerable emphasis is given and much light thrown on the "moral" oppression visited by the Empire on the gentle and ineffectual Koreans.

A party of about fifty students of the Woman's College, Manila, visited the College on September 4. They visited the Botanical and Zoological laboratories.

The following note from a recent number of *Science* is of special interest:

> At the recent Chicago meeting, the council of the American Association for the Advancement of Science directed the permanent secretary to appoint an assistant secretary, the duties of this officer being to aid the permanent secretary in the editorial and scientific aspects of the work of the association. Dr. Sam F. Trelease has been appointed assistant secretary. Dr. Trelease has recently returned to America after several years of service in the school of agriculture of the University of the Philippines at Los Baños. The assistant secretary will devote part of his time to the work of the association, being also on the staff of the laboratory of plant physiology of the John's Hopkins University.

Mr. Toribio Vibar, formerly instructor in Agronomy, accompanied by Mrs. Vibar, sailed in August for the United States. Mr. Vibar goes as University Fellow to the University of Illinois for advanced work in Agriculture.

Judging from a letter to Dean Baker, written in Hongkong, Mr. Vibar has the "seeing eye." He writes:

> I now have some ideas about Chinese life on the water, in the city, and in the country. Went to Canton yesterday by train. Chinese agriculture is very thorough. While our fields are absolutely weedy; theirs are absolutely weedless. Every phase of Chinese life seems to show economy. The size of the farm houses, the street arrangement, the size of the leaves in the rice fields, etc., all seem to show that the Chinese want to get the most out of everything. This is true also of the rickshaw men. Every one of them tries to squeeze from you the most they can. But not from me. I always give them the least. They howl; but I do not mind it. I can not understand them anyhow.

Dr. F. T. McLean resigned his position as head of the Department of Plant Physiology and left for the United States on August 18, 1921, to accept a position in California.

The Class of 1921 recently presented a fine silver loving cup to Professor Yule as an expression of their esteem and an appreciation of her tireless efforts in their behalf. The cup is a beautiful one and the act was a gracious one.

On the evening of September 2, Professor and Mrs. Welles entertained the students of the History classes at their home on Copeland Plaza. This is the first of a series of open house parties for students which they plan to hold during the school year.

On July 10, eighty-one students of the English 1 and 2 classes organized the English Club of the College of Agriculture under the advisership of Prof. T. R. Brenton. President Benton, Dean Baker, and Professor Yule are honorary members of the Club. The object of the organization is to provide cultural recreation for the students and to cultivate conversational use of English in the home-life. Several very interesting programs have been rendered. The organization of this Club was most opportune and will do much to stimulate English scholarship and comradeship among its members.

The students of the College fittingly observed Occupation Day, August 13. A well planned program was given in the lecture room of Botany Hall. Professor Yule in a very interesting address outlined the significance of America's occupation of the Philippines, emphasizing the doctrines of equal opportunity and work. Doctor Quisumbing gave a graphic talk on the City of New York and his student life there. Mr. Bengson, President of the Student Body, and Mr. Dadufalza made brief and appropriate speeches.

The new Animal Husbandry Building, a commodious concrete structure combining offices, laboratory, lecture, and recitation rooms and stock pavilion, is going up rapidly. The new Chemistry Building which is now occupied, and the Animal Husbandry Building are excellent examples of practical college buildings. Ventilation and sanitation have been given special attention and the result is a monument to our Engineering Department which planned them and superintended their construction.

The additional wing, a large lecture hall of the Entomology-Pathology Building has been finished and is occupied, temporarily, by the College of Veterinary Science.

The Hawaiian Sugar Planter's Insectary, which the Association presented to the College, is completed and is ready for use. The Insectary stands on a prominent site south of the Entomology-Pathology Building. Construction was under supervision of Professor Cuzner and Mr. Arrana of the Engineering Department.

Money has been released for completing the surfacing of Forest Road and work will soon be under way.

August 20 was celebrated as the First Annual Field Day of the Los Baños Colleges. Students of the three schools turned out in cleverly organized phalanxes and went "over the top" in the matter of cleaning the Parade, the Field, and the Diamond. Graduate assistants could be seen industriously at work, even faculty members showed a knowledge of the business end of a hoe. Exuberant spirit and hard work in the morning, exuberant spirit and athletics in the afternoon were topped off with a root crop "barbecue" late in the day.

Mr. Tranquilino Ventura, '19, visited the College for a few days in the last week of August. Mr. Ventura is Assistant Chemist of the Talisay-Silay Milling Co. of Occidental Negros.

Mr. Leopoldo S. Clemente, '16, has been granted the degree of Master of Science by the University of Illinois. He is majoring in genetics.

Mr. Leonardo Salinas, '21, is now with the Forestry Service at Sandakan, British North Borneo.

The Student Body has modified its constitution, substituting a Council made up of two representatives from each class for the former Executive Committee made up of the President and ex-Presidents.

The Student Body has passed resolutions looking toward the celebration of a "Loyalty Day" on October 10, the anniversary of the unanimous volunteering of this body for the National Guard in 1918.

The intercollegiate basketball season has opened and thus far progressed entirely satisfactorily to the College of Agriculture. Games and scores are as follows:

August 27; Education 4, Agriculture 70.
September 3; Liberal Arts 13, Agriculture 76.
September 17; Professional Colleges 13, Agriculture 45.

The Agriculture team is composed of students from the School of Forestry as well as from the College of Agriculture. The first team is the same as gave so good an account of itself last year. Rabaya in his old place at center is playing a better game than ever before. Lemos still holds the "tiger" guard position; Salazar, and Soliven are above par as forwards; and Antero-Cruz as running guard is playing at top speed.

A fortunate feature for future success is the work of the second team men. Crisanto has developed accurate throwing from a difficult angle, Tenebro shows strength at center, and Gordon performs the running guard position with ease. As we may lose some first line men next year it is of great importance that understudies be provided this year.

The Campus Baseball League, composed of Veterinary, Agriculture, and Forestry teams, has provided several spirited games. The standing is as follows:

	Games	*Won*	*Lost*	*Average*
Forestry	4	3	1	750
Agriculture	3	1	2	333
Veterinary	3	1	2	333

One game remains to be played between Agriculture and Veterinary to decide the "cellar" position.

Plans are now under way for holding the Second Annual Intramural Track and Field Meet the last of October.

Professor Woodworth is Athletic Director with Mr. Panganiban in charge of baseball; Professor McWhorter, of basketball; Mr. Nemesio Catalan, of track and field; Doctor Francisco, of tennis.

A college student once asked President Eliot of Harvard University if he could not take a shorter course than the one laid down in the prospectus of the institution. "That depends," replied the level-headed president, "upon what you wish to make of yourself. When nature wants to make an oak she works away on the job a hundred years, but if she only wants a squash she needs only about six months."